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MAN'S IMPACT ON THE OUTER BANKS OF NORTH CAROLINA

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DUNE STABILIZATION STUDY
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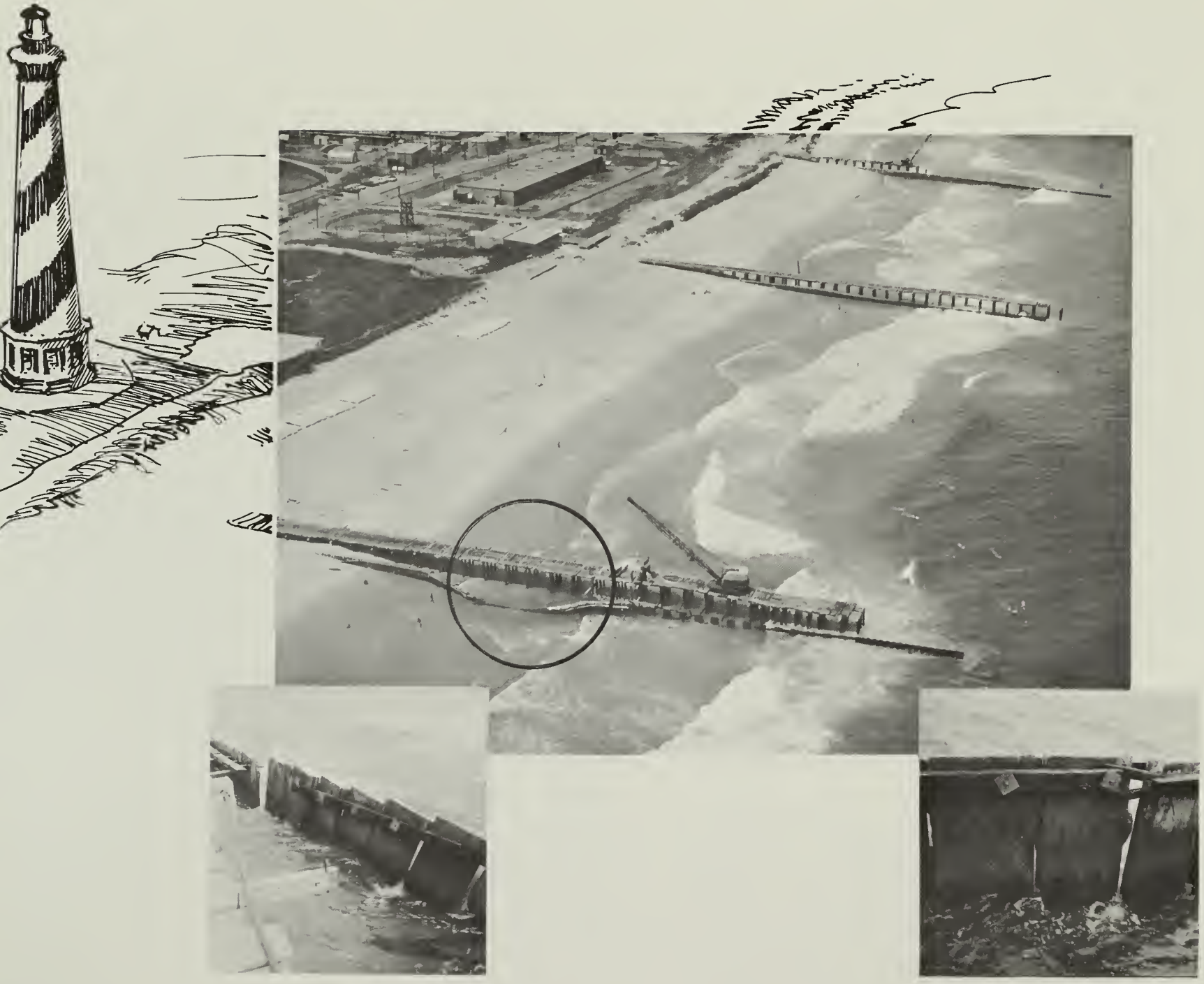
INTRODUCTION

MAN'S ROLE as as an agent of landscape change was a topic of interest to earth scientists and ecologists long before the 'environmental crisis' became a national issue in the United States. The list of distinguished scientists who have expressed concern about the effects of man on the natural environment is a long one, and spans a wide range of disciplines, but R.F. Peel's statement (1952) in a book on physical geography is clear and to the point:

> "The earth is not an inert and haphazard collection of materials that can be altered piecemeal without danger. Land, water, and air are all active, and all interact on one another through a host of connected processes. The physical environment of any region is somewhat like a highly complex machine, and a machine which is often rather delicately balanced. Unthinking alteration of one part of it will inevitably affect others, and may set in motion a sequence of changes having unforeseen consequences which may spread far beyond the immediate locality. Man has been producing such changes in the face of the earth for thousands of years through his practices of agriculture and animal husbandry, and the effects, until recently little heeded or even suspected, have in many areas been wholly disastrous. In considering the contribution a knowledge of Physical Geography can make to human welfare we may thus usefully glance at the effects, often quite unintentional, of man's interference with nature in the past."

Problems within the coastal zone offer excellent opportunities to investigate the impact of man's manipulations of the natural environment. This case study, conducted along the Outer Banks of North Carolina under sponsorship of the National Park Service, provides another view of how man might better work with the natural forces that have produced the coastal landscape, rather than against them.



BACKGROUND

For many years the policy of land management agencies was to control natural coastal processes which were thought to be destructive. In fact, this control has been described in terms of combat with nature. The Coastal Engineering Research Center (U.S. Army Corps of Engineers) conclude their technical report Land Against the Sea with this sentence (p. 43): "Our campaign against the encroachment of the sea must be waged with the same care that we would take against any other enemy threatening our boundaries." This strategy has, in many cases, resulted in unbalanced coastal processes which commonly culiminate in undesirable shoreline responses.

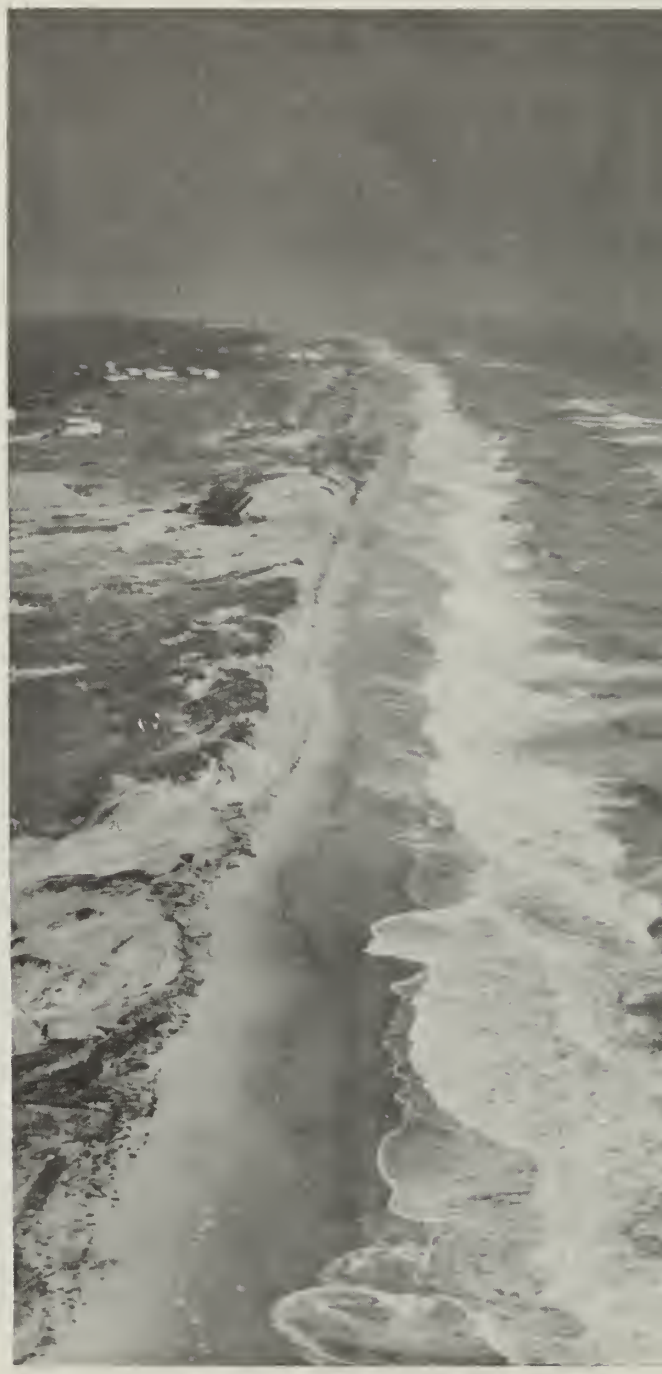
Through experience and extensive trial-and-error engineering with sea walls, groins, and land fills, we are now beginning to realize that natural change is often essential to the maintenance of geologic and ecologic systems. It is also clear that an uncontrolled natural system, undergoing periodic changes, creates serious land management problems. This means that extensive areas must be maintained safely for those who wish to use them for recreation purposes, and yet it is desirable to have these same systems remain in a dynamic physical state.

This management contradiction becomes a serious problem in areas subject to the greatest physical stresses. The barrier islands of North Carolina provide an excellent example of the dilemma land managers face today along the mid-Atlantic coast. The low profile of these islands, their narrowness, sand composition, exposure to high wave energy, coupled with a gradually rising sea-level, have created a state of continual physical and ecological change.

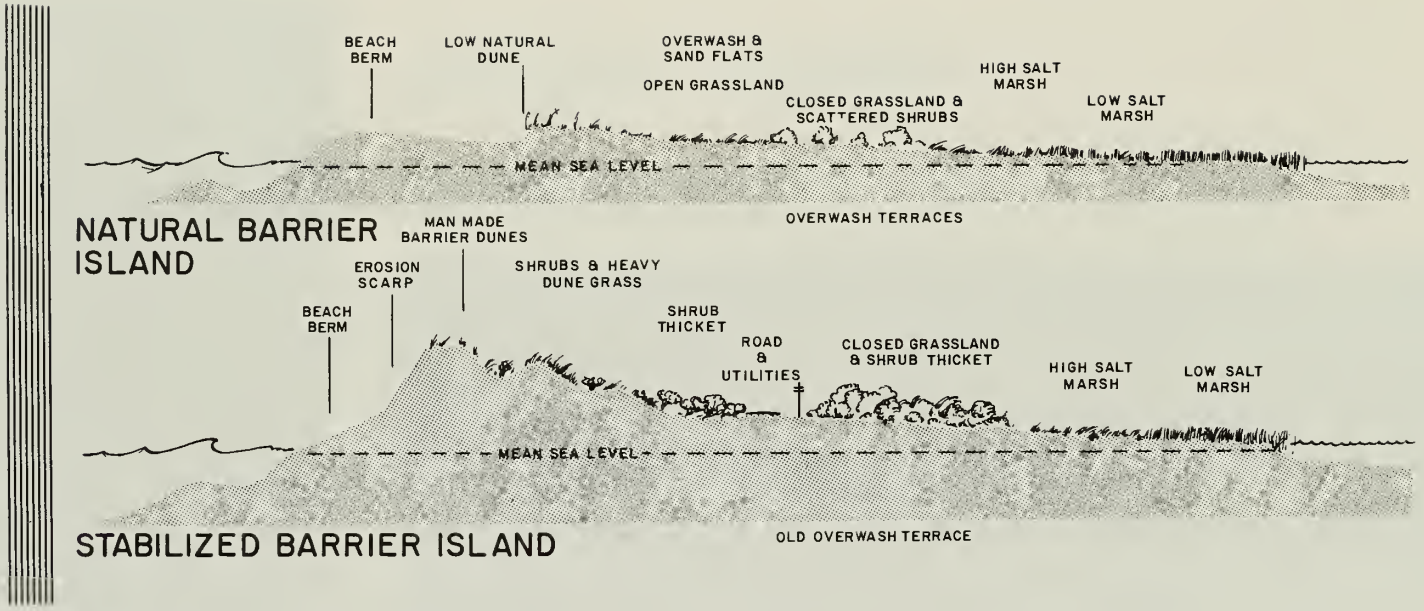
OUTER BANKS

The Outer Banks extend from the Virginia-North Carolina border south to Cape Lookout, a distance of 140 miles. Originally, these islands were one continuous biophysical system, but the upper section has experienced more than 40 years of dune and beach stabilization, coupled with extensive shoreline development. In 1957 the stabilized islands became the Cape Hatteras National Seashore. The southern segment of the Outer Banks, which includes Portsmouth Island and Core Banks, remains in essentially a natural state and is authorized to become part of the new Cape Lookout National Seashore. The responses of these two systems to waves and storm tides are of special interest to the National Park Service for both preservation and management reasons. They can also be compared to determine some of the geologic implications of man-made modifications, as well as the economics associated with maintaining altered environments.

BROAD, NATURAL BEACH



NARROW,
"STABILIZED" BEACH



THE NATURAL SYSTEM

The earliest known descriptions of the Outer Banks date from the late 18th century; however, by this time the islands had been settled and cattle, sheep, horses, and hogs had been introduced for at least one hundred years. For this reason, some uncertainty exists concerning the extent to which the islands were vegetated prior to 1800. Some ecologists suggest that the islands were originally more extensively vegetated, and that grazing and woodcutting by the early settlers combined to denude the islands of grasses and trees, creating a somewhat desolate, unnatural condition.

The presence of man and domesticated animals have surely had some effect on the vegetation of the Outer Banks. However, there are several indicators that the islands have always been sparsely vegetated. For example, regular occurrence of storm surges and oceanic overwash, and extreme tides from Pamlico Sound preclude the development of permanent forests except at a few broader areas, such as at Buxton, where relatively high back dunes have formed near the sound.

The unaltered barrier island system can adjust to periodic storms since there are no natural obstructions in the path of the waves and surges. Most of the initial storm stress is sustained by the broad beaches. Because no resistance is created by impenetrable landforms, water flows between the dunes and across the islands with the result that energy is rapidly dissipated. On the sound side the fringes of marsh act as a buffer to reduce erosion from waves and surges generated on Core and Pamlico Sounds.

The combination of extreme high tides and large waves occasionally succeeds in eroding the low-lying beach foredunes, carrying sediment completely across the island and into the marshes. This process of "oceanic overwash" has been well documented by Dr. Paul Godfrey, who has shown the important role overwash plays in marsh formation by replenishing sediments and creating new land on the sound side of barrier islands.

THE "STABILIZED" SYSTEM

The frequency of destructive storms along coastal North Carolina, coupled with oceanic overwash, prevented the establishment of a permanent road network on the Outer Banks until the 1930's. It was determined at that time to construct a protective dune system between the proposed road and the beach. In the period between 1936 and 1940, the CCC and WPA, under the direction of the National Park Service, erected almost 3,000,000 feet of sand fencing to create a continuous barrier dune along the Outer Banks--including Hatteras, Pea, and Bodie Islands. Most of this construction took place in the zone comprising the original low beach dunes and a strip 100 to 300 feet wide behind the fore dune. The sand which collected around the fencing was further stabilized with some 2,500,000 trees and shrubs, and enough grass to protect 3,254 acres of dunes and sand flats. This was augmented in the late 1950's by the National Park Service, so that at present almost a continuous mass of vegetation blankets the barrier island from South Nags Head to the southern tip of Ocracoke Island.

There are few plants that can tolerate the extreme conditions in the vicinity of a beach subject to high wave action. The representative profiles across the Core Banks, illustrate two important points: 1) a wide zone of no vegetation between the shoreline and the extreme backshore, and 2) low dune overwash in the central part of the island. In contrast, along a profile across the stabilized and fertilized dunes on Hatteras Island, grasses may be as close as 30 to 60 feet of the high tide line, because of increased protection from storm surge. The great height of the stabilized dunes, up to 30 feet, provides a region of protection from salt spray and flooding, allowing extensive growth of shrubs within 100 feet of the high water mark. The high stabilized dunes not only divert salt spray from the zone immediately behind the dune, but they also prevent flooding and overwash. Because of this protection, the shrub community normally found near the back of the islands has spread seaward, and in many places forms an impenetrable thicket 10 to 15 feet high. Attempts are now underway to check the spread of shrubs by several methods, including controlled fires.

ARTIFICIAL BARRIER DUNES

From a geological point of view, the Outer Banks of North Carolina are one of the most dynamic systems in nature. Because oceanic overwash plays an essential role in this process, an unbalanced situation develops wherever artificial barrier dunes have been built. Further compounding the seriousness of the situation has been the false impression of safety and stability offered by the barrier dune. Numerous structures, including motels, restaurants, beach cottages, park facilities, and a U.S. Naval Base at Cape Hatteras have been built immediately behind the barrier dune in the belief that the dunes provide permanent protection from encroachment by the sea. Instead, tne beach has steadily narrowed. Subsequently, the barrier dune has eroded away leaving these structures with little protection from extreme events.

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MAN'S RESPONSE

Oceanic overwash, and the opening and closing of inlets, creates serious problems in maintaining a permanent highway down the center of the Outer Banks. In the past it has been necessary to clear the highways when covered with sand deposited by overwash, and the roads have been rerouted several times when erosion destroyed the dunes and threatened the fixed routes. Bridges have been abandoned and roads built where inlets have closed. In other cases it has been necessary to fill in recently formed inlets and replace the destroyed highway. The Ash Wednesday storm of 1962, for example, opened a new inlet between Buxton and Avon which required 1.5 million dollars to fill in and rebuild the dune system and replace the roadway. This same storm destroyed segments of over 15 miles of the artificial barrier dune system, which also had to be rebuilt.

Although the present system in undependable, endangered, and expensive to maintain, alternatives are even more expensive and somewhat questionable in terms of application and economics. One approach has been to attempt to maintain the beaches by constructing groins at right angles to the beach, or by dredging sediments and pumping them into the beach. The cost of groin fields runs into millions of dollars, and yet they have not been very effective on the Outer Banks at Hatteras Lighthouse. Dredging and beach nourishment may cost $1,000,000 per mile, and in most cases this too is only a temporary measure.

STRATEGY

Survival of the natural beach environment along coastal North Carolina requires a strategy of submission and rapid rebuilding. This is the key to success for the natural systems. Unfortunately, man has attempted to draw a line and prevent the sea from passing. The results have been unexpected and negative. Because the Cape Hatteras portion of the Outer Banks has already developed to the point where it is impossible to remove the highway, it must be maintained; however, as the system continues to narrow, new instances of overwash, erosion of the artificial barrier dunes, and inlet formation can be forecast. Many of the structures which have been built in the proximity of the shoreline will be lost and the highway will require relocation within a few years.

The Cape Lookout section of the Outer Banks on the other hand presents an entirely different situation. The islands from Portsmouth Island south to Cape Lookout and then west along Shackleford Bank is undeveloped. There are no highways, utilities, and permanent settlements to protect. Placement of a permanent roadway down the island would require a continuous artificial dune system for protection and stabilization. The National Park Service plan is, however, to leave Portsmouth Island, Core Banks, and Shackleford Banks in a natural state.

MAN'S ROLE.....

With the rapid deterioration of the barrier dune systems along the Outer Banks of North Carolina in recent years, and the large expenditures necessary to re-establish or maintain them, research supported by the National Park Service suggests that this is the time to review the basic concept of dune construction and shoreline modifications in light of the geological implications. For example, overwash is the major means by which low barrier islands retreat before the rising sea. In fact, it is the only way massive quantities of coarse material can be moved inland from the beach.

If sea level continues to rise, as evidence seems to suggest, the resources required to maintain extensive areas of barrier dunes in some areas may exceed the economic and psychologic value attached to their existence. Barrier islands, in their natural condition, survive severe perturbations of tropical and extra-tropical storms by the low resistance they present to storm surges. The natural islands are not being washed away but rather they are moving back by processes that were fundamental in their origin, processes that continue to be important if the islands are to be preserved in a natural state. The lesson is clearly documented. The best strategy for continued use of the land and water resources of barrier islands is in most cases man with nature, not man against nature.